CONCISE STATEMENT OF RELEVANCE

for

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This invention is a plasma generating device that provides plasma uniformly at a central part and a peripheral part of a plasma space.

PATENT ABSTRACTS OF JAPAN

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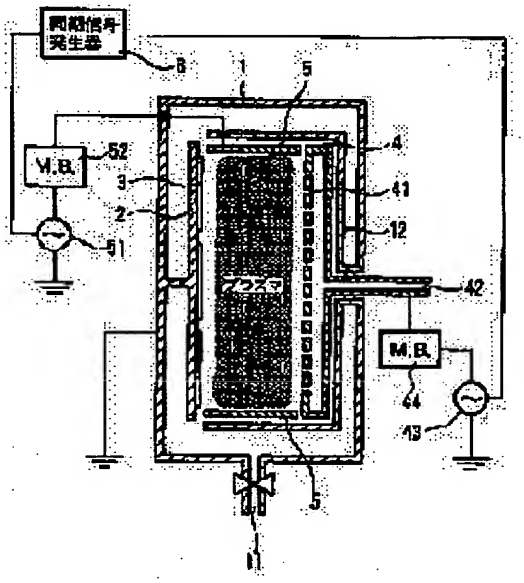
(54) PLASMA GENERATING DEVICE

(57) Abstract:
PURPOSE: To make the property of plasma uniform at the central part and peripheral part of a plasma space.
CONSTITUTION: An intermediate electrode 5 is formed by surrounding the periphery of a plasma space formed between a high-frequency electrode 4 and earth electrode 2 with a metallic plate and the frequency and phase of the voltage applied across the intermediate electrode 5 from a high-frequency power source 51 are made coincident with the frequency and phase of the voltage applied across the electrode 4. In addition, the crest value of the electrode 5 is controlled between those of the electrodes 4 and 2.



LEGAL STATUS

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CLAIMS

[Claim(s)]

[Claim 1] In the plasma generator which carries out opposite arrangement of the RF electrode and ground electrode which supply high-frequency power to introductory gas, and is made to generate the plasma between two electrodes in a vacuum housing While covering the perimeter of the plasma space formed between the above-mentioned RF electrode and a ground electrode and preparing a bipolar electrode To the above-mentioned bipolar electrode, with the frequency, the same frequency as a phase, and phase of the high-frequency voltage impressed to the above-mentioned RF electrode The plasma generator characterized by establishing an electrical-potential-difference impression means to impress the high-frequency voltage which takes the value between these peak value in which the peak value includes the peak value of an RF electrode thru/or the peak value of a ground electrode.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the plasma distribution control for performing especially homogeneity membrane formation about the plasma generator used for plasma-CVD equipment etc.
[0002]
[Description of the Prior Art] An example of the conventional plasma-CVD equipment which installed the plasma generator inside is shown in drawing 8 . In drawing, a vacuum housing 1 has the flueing opening 11, it is exhausted by the vacuum pump of ****, and the interior is maintained at the vacuum. In the above-mentioned vacuum housing 1, the substrate tray 2 and RF electrode 4 holding a substrate 3 of ground potential counter, and are arranged. Above-mentioned RF electrode 4 is a flat bottle object, many gas inlets 41 are formed in a substrate 3 and the front face which counters, and the gas installation tubing 42 is connected to the rear face. A deer is carried out and membrane formation gas is introduced in a vacuum housing 1 through a gas inlet 41 from gas installation tubing.
[0003] The introduced membrane formation gas will be from RF generator 43 in the plasma state with the power supplied through a matching box 44 and RF electrode 4, causes a chemical reaction on plasma space or the front face of a substrate 3, deposits it on a substrate 3, and forms a thin film.
[0004] However, the above-mentioned conventional plasma-CVD equipment is with a center section and the periphery of the substrate tray 2, and had the problem that the thickness of the thin film formed and membraneous quality were uneven, and a large homogeneity membrane formation area could not be taken for this reason. It is thought that one of the cause of this is for the properties of the plasma of a center section and the periphery of plasma space to differ, and some approaches for solving this are proposed.
[0005] For example, in the Provisional-Publication-No. 63-No. 186419 official report, the side face of an RF electrode is surrounded with the shielding frame made into a substrate electrode holder and this potential, the plasma is shut up between electrode pairs, and it is going to cancel the ununiformity of the plasma (the 1st conventional example). On the other hand, in the effective 64-No. 1958 official report, a discharge electrode plate is divided into plurality and adjusting the density distribution of the plasma is examined by controlling independently the high-frequency power introduced into each discharge electrode plate (the 2nd conventional example).
[0006]
[Problem(s) to be Solved by the Invention] However, according to this invention person's etc. experiment, equalization of the plasma is not yet enough by the plasma generator of the 1st conventional example. Moreover, it is still difficult not to equalize the property of the other plasma but to form thickness and the uniform thin film of membraneous quality in the 2nd conventional example, although it is effective in control of plasma density distribution.
[0007] According to the experiment and simulation which this invention person etc. performed, the cause of the plasma ununiformity in equipment is conventionally for the surface ratio of an RF electrode and a ground electrode to differ by the center section and periphery of plasma space. That is, in the conventional plasma-CVD equipment shown in drawing 8 , in the center section of plasma space, since the wall of a vacuum housing 1 functions as a ground electrode by the periphery to the surface ratio of RF electrode 4 and a ground electrode (substrate tray 2) being about 1:1 in addition to the substrate tray 2, surface ratio becomes 1:a (a> 1). Thus, the area of a ground electrode is large by the periphery, and it is thought that the difference in this electrode surface product causes a plasma ununiformity.
[0008] A deer is carried out, and when it is made for the surface ratio of the RF electrode in the periphery of plasma space and a ground electrode to become equal to the surface ratio in a center section, it equalizes the property of the plasma of a center section and a periphery by this and the object of this invention applies it to membrane formation equipment, it is to offer the plasma generator which can form thickness and the uniform thin film of membraneous quality.
[0009]
[Means for Solving the Problem] In the plasma generator which carries out opposite arrangement of RF electrode 4 and the ground electrode 2 which supply high-frequency power to introductory gas, and is made to generate the plasma between two electrodes 2 and 4 in a vacuum housing 1 when drawing 1 explains the configuration of this invention While covering the perimeter of the plasma space formed between above-mentioned RF electrode 4 and the ground electrode 2 and forming a bipolar electrode 5 To the above-mentioned bipolar electrode 5, with the frequency, the same frequency as a phase, and phase of the high-frequency voltage impressed to above-mentioned RF electrode 4 An electrical-potential-difference impression means 51 to impress the high-frequency voltage which takes the value between these peak value in which the peak value includes the peak value of an RF electrode thru/or the peak value of the ground electrode 2 is established.
[0010]
[Function] In the above-mentioned configuration, if the peak value of a bipolar electrode 5 is adjusted to

one half of RF electrodes 4, the surface ratio of the RF electrode of a periphery and a ground electrode will be seen electrically, and will be set to 1:1. Therefore, the property of the plasma of a periphery becomes the same as a center section, and the membraneous quality of the thin film by which laminating formation is carried out, and thickness are equalized by the center section and the periphery by the substrate formed on the ground electrode 2. Furthermore, if the peak value of a bipolar electrode 5 is changed, the surface ratio of the RF electrode of a periphery seen electrically and a ground electrode can be changed. Therefore, the property of the plasma of a periphery can be controlled and it is also possible to control the membraneous quality of a periphery and thickness to a predetermined thing to the membraneous quality of a center section and thickness.

[0011]

[Example 1] An example of plasma-CVD equipment which used the plasma generator of this invention for drawing 1 is shown. In drawing, it has the flueing opening 11 on a base, internal gas is discharged by the vacuum pump of ****, and the vacuum housing 1 is held at the vacuum. In the above-mentioned vacuum housing 1, you make it hold to the wall, the substrate tray 2 is arranged, and the substrate 3 is held on this substrate tray 2. In addition, this substrate tray 2 functions as a ground electrode.

[0012] RF electrode 4 is arranged on the opposite location of the above-mentioned substrate 3. Many gas inlets 41 are formed in the front face which counters the above-mentioned substrate 3 of this RF electrode 4, and membrane formation gas is introduced in a vacuum housing 1 through the gas installation tubing 42 connected to the tooth back. Above-mentioned RF electrode 4 is connected to RF generator 43 installed outside through the matching box 44.

[0013] A building envelope is surrounded between the periphery edge of RF electrode 4, and the periphery edge of the substrate tray 2, the bipolar electrode 5 is formed in it tubed, and this bipolar electrode 5 is connected to other RF generators 51 through the matching box 52. It is fixed in the vacuum housing 1 using the insulating material, and a bipolar electrode 5 is independently electrically also from the substrate tray 2 which is a ground electrode also from RF electrode 4. It has prevented having formed the ground covering 12 which follows a vacuum housing 1 behind above-mentioned RF generator 4 and the bipolar electrode 5 in the predetermined gap, and discharge arising between each [these] electrodes 4 and 5 and the wall of a vacuum housing 1.

[0014] The membrane formation gas introduced in the vacuum housing 1 will be from above-mentioned RF generator 43 in the plasma state with the power supplied through a matching box 44 and RF electrode 4. And a chemical reaction is caused on the front face of the plasma space formed between the above-mentioned substrate tray 2 and RF electrode 4, or the above-mentioned substrate 3, it deposits on a substrate 3, and a thin film is formed.

[0015] Since the synchronizing signal from a synchronizing signal generator 6 has inputted into RF generators 43 and 51 and high-frequency voltage is generated with both synchronizing signals, the frequency and the phase of high-frequency voltage [the high-frequency voltage impressed to a bipolar electrode 5 and] impressed to RF electrode 4 correspond. Moreover, in RF generator 51, the output peak value can be set as arbitration among these peak value including the output peak value and ground peak value of RF generator 43.

[0016] Hereafter, actuation of equipment is explained. The membrane formation gas introduced in the vacuum housing 1 will be from above-mentioned RF generator 43 in the plasma state with the power supplied through a matching box 44 and RF electrode 4. And a chemical reaction is caused on the front face of plasma space or the above-mentioned substrate 3, it deposits on a substrate 3, and a thin film is formed.

[0017] In this case, if the peak value of the high-frequency voltage impressed to a bipolar electrode 5 is adjusted so that it may be set to one half of the peak value impressed to RF electrode 4, the above-mentioned bipolar electrode 5 is seen electrically, and will be in the condition that they are not any of RF electrode 4 and the substrate tray 2, either. That is, since the ground electrode of a periphery seen from RF electrode 4 serves as only the substrate tray 2 the same as for a center section, the surface ratio of RF electrode 4 and a ground electrode (substrate tray 2) is set to 1:1.

[0018] When drawing 2 explains this effectiveness, drawing shows the plasma density distribution change of plasma space when changing the peak value of the high-frequency voltage impressed to a bipolar electrode 5, an axis of abscissa is the distance from a core, and an axis of ordinate is the ion current (plasma consistency). If the peak value (Vmid) of the high-frequency voltage impressed to the above-mentioned bipolar electrode 5 is adjusted to one half of the peak value (Vrf) of the electrical potential difference impressed to RF electrode 4 so that clearly [drawing], the ion current will become related almost fixed from a core at distance.

[0019] The thickness of the thin film actually formed on a substrate 3 is not determined by only the plasma consistency, and changes with membrane formation pressures etc. Then, if the electrical-potential-difference peak value (Vmid) of a bipolar electrode 5 is made to change suitably between the electrical-potential-difference peak value (Vrf) of RF electrode 4, and the electrical-potential-difference peak value (= 0) of the ground electrode 2, the **** thickness distribution shown in drawing 3 is acquired, and in this case, at the time of Vmid =Vrf, the thickness difference of a periphery and a center section becomes sufficiently small, and serves as homogeneity.

[0020] A uniform thin film can be formed all over a substrate 3 by changing the high-frequency-voltage peak value of a bipolar electrode 5 according to a membrane formation pressure etc., and not producing discharge in this way, between a bipolar electrode 5, RF electrode 4, or the ground electrode 2, or producing proper discharge. In addition, it is possible not only equalization of thickness but to control the thickness of a periphery to a predetermined thing to the thickness of a center section.

[0021]

[Example 2] He connects RF electrode 4 and a bipolar electrode 5 to one RF generator 43, and is trying to control the electrical potential difference impressed to the above-mentioned bipolar electrode 5 with the electrical-potential-difference peak value regulator 7 in drawing 4 . Other configurations and actuation are

the same as that of the 1st example of the above. The same effectiveness as the 1st example can be acquired also by this configuration.
[0022]
[Example 3] Moreover, high-frequency voltage may be impressed to a bipolar electrode 5 by allotting like drawing 5 , so that the edge of a bipolar electrode 5 may be inserted between RF electrode 4 and the ground covering 12, and carrying out capacity coupling of above-mentioned RF electrode 4, a bipolar electrode 5 and a bipolar electrode 5, and the ground covering 12 electrically. In this case, the peak value of the electrical potential difference of a bipolar electrode 5 is controllable to arbitration by changing the ratio of the magnitude of the gap of RF electrode 4 and a bipolar electrode 5, and the gap of a bipolar electrode 5 and the ground covering 12.
[0023]
[Example 4] Capacity coupling of each above-mentioned electrode may be carried out using the variable-capacity capacitors 81 and 82 like drawing 6 . In this case, if the capacity of each capacitor is changed, the peak value of the electrical potential difference of a bipolar electrode 5 is controllable to arbitration.
[0024]
[Example 5] Furthermore, when the pressure in a vacuum housing 1, temperature, etc. change with time amount and thickness and membraneous distribution receive effect in those conditions, feedback control of the peak value of the high-frequency voltage which supervises plasma distribution and is impressed to a bipolar electrode 5 may be carried out. That is, like drawing 7 , the plasma monitor 91 is arranged on the center section and periphery of plasma space, and it connects with the feedback control machine 92, and if it makes as [adjust / the peak value of the high-frequency voltage impressed to a bipolar electrode 5 by the result], thickness and membraneous quality will be maintained more at homogeneity, and the thing of them can be carried out. In addition, although the example which added the feedback mechanism to the configuration of an example 1 was shown in drawing, this feedback control can be used for all of the examples 2-4 shown in the above-mentioned drawing 4 -6.
[0025] In addition, if this invention is vacuum devices which use plasma, such as not only plasma-CVD equipment but a sputtering system, an etching system, etc., it is applicable to all.
[0026]
[Effect of the Invention] As mentioned above, since the plasma generator of this invention can control the plasma distribution in plasma space easily, it can be applied, for example to plasma-CVD equipment, can cancel the ununiformity of the plasma in a center section and a periphery, and can form thickness and the uniform thin film of membraneous quality in a larger area.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the whole plasma-CVD equipment sectional view in the example 1 of this invention.
[Drawing 2] It is drawing showing ion current distribution of plasma space.
[Drawing 3] It is drawing showing the thickness distribution on a substrate tray.
[Drawing 4] It is the whole plasma-CVD equipment sectional view in the example 2 of this invention.
[Drawing 5] It is the whole plasma-CVD equipment sectional view in the example 3 of this invention.
[Drawing 6] It is the whole plasma-CVD equipment sectional view in the example 4 of this invention.
[Drawing 7] It is the whole plasma-CVD equipment sectional view in the example 5 of this invention.
[Drawing 8] It is the conventional plasma-CVD equipment whole sectional view.
[Description of Notations]
1 Vacuum Housing
11 Flueing Opening
12 Ground Covering
2 Substrate Tray (Ground Electrode)
3 Substrate
4 RF Electrode
41 Gas Inlet
42 Gas Installation Tubing
43 RF Generator
44 Matching Box
5 Bipolar Electrode
51 RF Generator
52 Matching Box
6 Synchronizing Signal Generator

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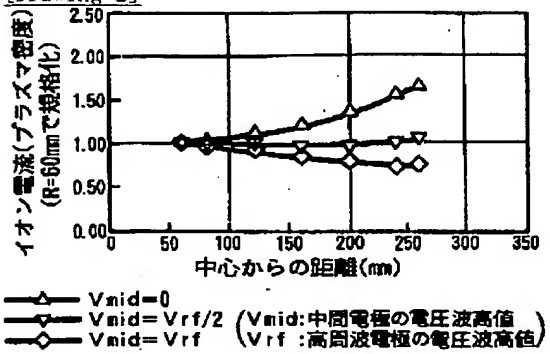
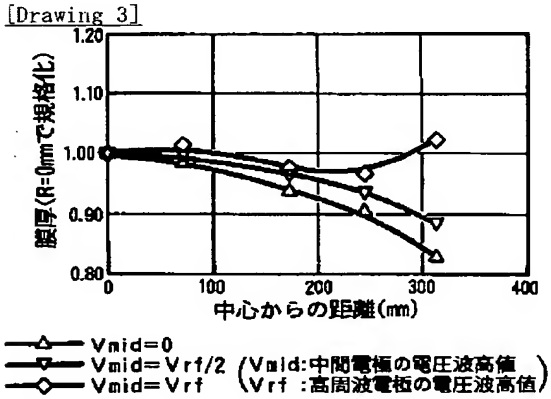
DRAWINGS

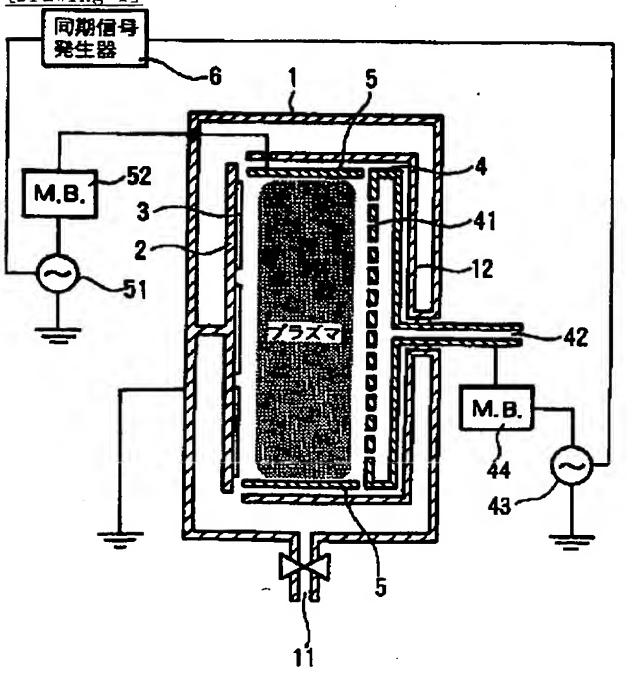
[Drawing 2]



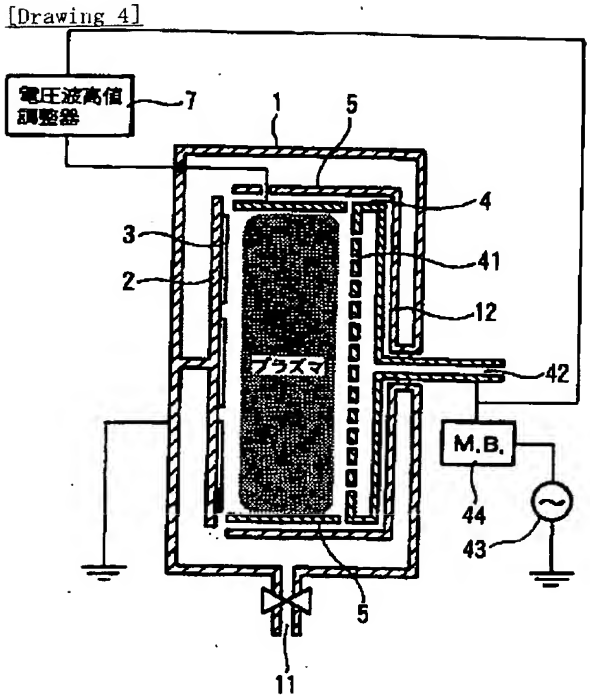
[Drawing 3]



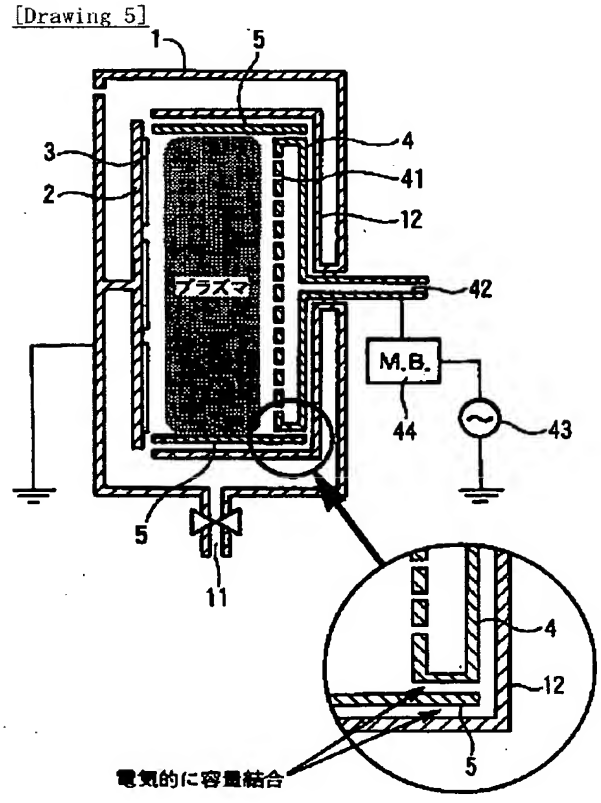
[Drawing 1]



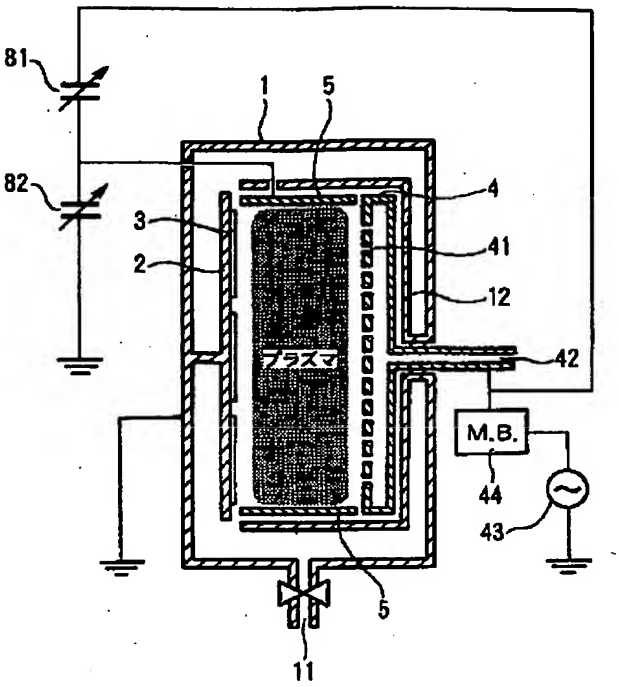
[Drawing 4]



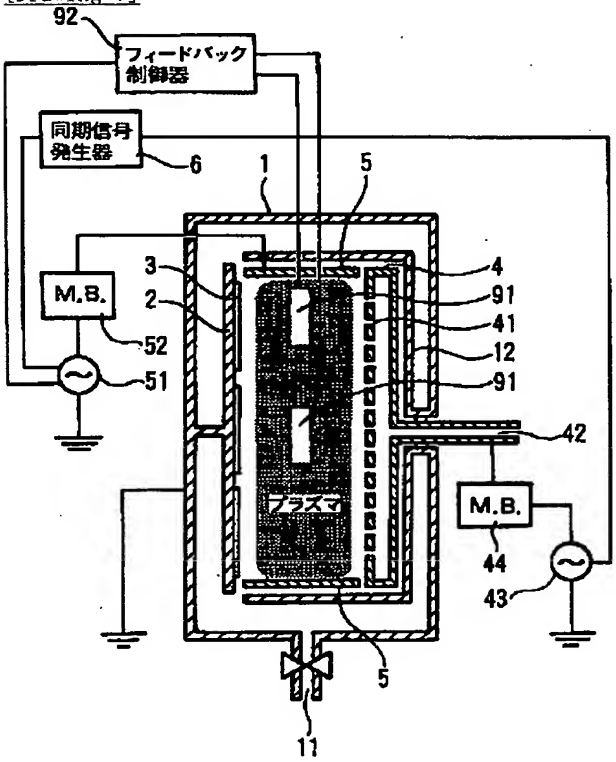
[Drawing 5]



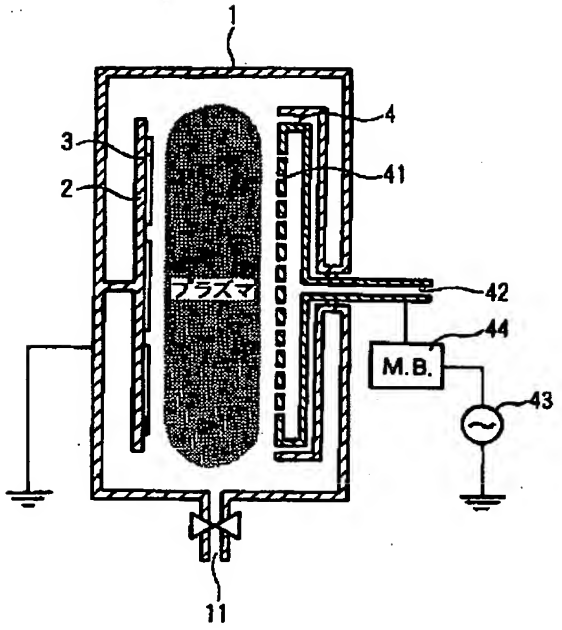
[Drawing 6]



[Drawing 7]



[Drawing 8]



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